Knowledge and practices on safe handling, preparation and administration of cytotoxic drug among oncology Nurses

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Abstract:

Nurses, responsible for cytotoxic drugs (CDs) administration, face occupational exposure to these antineoplastic agents. This necessitates nurses to be vigilant and knowledgeable about the CDs' safe handling, ensuring the well-being of patients, themselves, and maintaining a safe working environment. Surprisingly, a gap exists in Palestinian research literature, with no studies evaluating nurses' adeptness in handling these drugs. This study, therefore, seeks to address this void, aiming to gauge the proficiency and practices of oncology nurses in both private and governmental cancer hospitals in Palestine. Positive outcomes from this research could set the foundation for augmenting care quality, enhancing knowledge dissemination, and cultivating best practices among oncology nurses. The insights from the study are somewhat disconcerting, indicating a deficiency in nurses' knowledge and practices concerning CD safety. This gap exists despite a majority having undergone formal training in chemotherapy handling. Distinct differences in knowledge levels were evident when factoring in age and experience duration with CDs. Furthermore, statistical correlations were found between the mean scores of knowledges and practices against variables like age, educational qualifications, and specific CD handling practices like receiving and storing. A silver lining, however, was the frequent usage of protective gear like gloves and masks by nurses during CD handling.

Key words: Knowledge; practices; safe handling; cytotoxic drugs; oncology nurses.

1. Introduction

In 2020, approximately 19.3 million new cases of cancer were reported worldwide, making it the leading cause of mortality and a significant impediment to increasing life expectancy. The safe handling of cytotoxic drugs (CDs) is a global concern due to potential toxic residues infiltrating hospital environments and patient care areas, even extending to patients' homes. Antineoplastic Drugs (ANPDs) are a class of medications used to inhibit or slow the growth of cancerous cells, including alkylating agents, anti-metabolites, antibiotics, mitotic inhibitors, and hormones.

Cytotoxic drugs (CDs) are antineoplastic, anticancer, or cancer chemotherapy drugs that interfere with cell division and destroy tumor cells. They can be categorized into numerous subgroups depending on their chemical structure and pharmacodynamics. The widespread use of chemotherapy in the treatment of cancer has led to higher health hazards among nurses who handle and administer such drugs. Inappropriate handling and use of CDs lead to occupational health hazards among workers in cancer management settings, particularly nurses. Knowledge deficits about CD handling may threaten personal safety or the safety of the patient. Poor handling practices, such as inconsistent use of personal protective equipment (PPE), have been reported in several studies.

Developing countries have a lower degree of compliance with recommended guidelines developed by the National Institute for Occupational Safety and Health (NIOSH), the Occupational Safety and Health Administration (OSHA), the Oncology Nursing Society (ONS), and the American Society of Hospital Pharmacists (ASHP). Negative side effects of chemotherapy exposure may cause damage at the cellular level, raising cancer risk. Leukemia is a lethal hematological malignancy that affects individuals across various age groups, resulting in substantial economic and societal consequences. Research has shown that leukemia patients in Japan are exposed to three distinct groups: Japanese atomic bomb survivors, women with cervical cancer treatment, and patients receiving irradiation for ankylosing spondylitis. The Japanese Government incurred around USD 2.5 billion for the treatment of leukemia patients between 1996 and 2014.

In India, the predominant forms of cancer include breast, lung, oral, cervical, uterine, and lingual malignancies. The 2020 Cancer Statistics Report predicted an incidence rate of 94.1 per 100,000 persons for men and 103.6 per 100,000 individuals for females. Abu-Rmeileh et al. identified lung cancer as the predominant cause of mortality among males (22.8%), while

breast cancer emerged as the leading cause of death among females (21.5%). The mortality rate for lung cancer increased among men residing in the northern regions of the West Bank, while the death rate for prostate cancer was greater in both the northern and southern regions of the West Bank.

A study estimated a global chemotherapy demand of 3.2% to 4.3% between 2018 and 2040, particularly in low-income countries (LIC). Mohsen and Fareed's 2013 study focused on the development of a "Chemotherapy safety protocol for oncology nurses," emphasizing the importance of adopting robust safety protocols to mitigate associated risks. Esmail et al.'s 2016 study provided insight into the existing knowledge and practices of oncology nurses in Erbil City, emphasizing the need for continuous training and development in this domain. Cytotoxic drugs used in cancer treatment pose inherent risks to healthcare professionals, and there is a lack of information about the extent of awareness and adherence to safe handling, preparation, and delivery protocols of cytotoxic medications among oncology nurses.

2. Cytotoxic medications for cancer patients

A variety of chemicals are dubbed cytotoxic, antineoplastic, anticancer, or cancer chemotherapeutic medicines. They are commonly used as cancer therapies because they limit cell division and kill tumor cells[42]. Cytotoxic medicines have numerous categories based on their chemical structure and pharmacodynamics. Alkylating compounds, antimetabolites, antitumor antibiotics, topoisomerase inhibitors, mitotic inhibitors, and other cytotoxic drugs are included. Alkylating compounds attack DNA. Antitumor antibiotics are chemotherapeutic medicines with many mechanisms [43]. Some drugs may intercalate into DNA, forming inter- and intrastrand cross-links. Antimetabolites replace normal metabolites with aberrant ones or block critical enzymes to impair nucleic acid synthesis. Many medications are chemically related to folic acid, purines, or pyrimidine. Plant Alkaloids These drugs limit mitotic spindle formation by binding to tubulin, a microtubule protein. Cytotoxic medications were originally utilized to treat cancer in the early 20th century; chemotherapy followed and was used to treat several cancers[44]. Nearly half of cancer patients will get chemotherapy, the main treatment. Cytotoxins cause cancer, mutation, and teratogens. If these medications are mishandled, cancer management workers endanger occupational health. Nurses who handle cytotoxic drugs may get cancer[45].

The highest occupational exposure risk is preparing and administering cytotoxic medicines (CDs), cleaning CD spills, and handling patient excreta. Cytotoxic medicines enter the body by

ingestion, skin absorption, aerosolized droplet inhalation, and liquid splashes. Other exposures include eating and needle stick injuries[46]. The health risks of cytotoxic drugs have been extensively studied[47]. Acute side effects include hair loss, nausea, vomiting, and digestive issues. Nurses exposed to the toxin may have had infertility, abortion, and fetal abnormalities[48]. These medications are crucial to cancer treatment. Safe handling of cytotoxic drugs should be practiced wherever they are transported, received, stored, prepared, delivered, or disposed of. Nurses commonly handle cytotoxic medicines, therefore their comprehension and practice require improvement[49].

Safe nursing practice requires knowledge in all scenarios, but cytotoxic medicine handling need it most. Because a lack of understanding regarding dangerous medications might endanger the nurse or the patient. Occupational exposure to cytotoxic drugs is a global concern[50]. The cytotoxic chemical might have harmed over 5.5 million workers. Unsafe handling practices have been noted as an issue in several studies, especially in countries where access to and use of these medications have increased [33]. In Nagpur, India, 56% of nurses handled cytotoxic medicines poorly [51].

Cytotoxic drugs have proven risky for medical workers since the 1970s [52], and various studies have linked occupational exposure to antineoplastic drugs to cancer [53,54]. However, proving a link between cytotoxic contamination and its harmful effects is difficult, and regulatory organizations have not set a maximum tolerated level for these drugs. Biomonitoring requires sensitive and specific methods to identify and quantify cytotoxic chemicals in urine or blood. The evaluation of cytotoxic chemicals in biological samples from healthcare providers lacks recognized and regulated methods [55,56]. Because of this, nurses must learn how to protect themselves, their patients, and their workplace culture from cytotoxic drugs. Cytotoxic medicines may cause cancer, teratology, and genetic abnormalities in humans. Nurses treated with cytotoxic drugs reported hair loss, skin infection, dermatitis, skin flushing, light-headedness, vomiting, and disorientation. These nurses noticed a skin flush[57].

3. Literature on nurse's knowledge of cytotoxic drug handling

A Pakistani research found that 3% of individuals scored 80% in chemotherapy safe handling knowledge and 54.3% scored 60%[58]. A cross-sectional study indicated that 65.5% of nurses in Tehran, Iran's three tertiary care teaching hospitals knew about cytotoxic drugs.[59] Another analytic cross-sectional research on nurses' chemotherapy knowledge and management in Nepal found a mean score of 61.32.[60] None of the nurses learned about Egypt,

Iran, or Nepal's cytotoxic drug research[61, 62]. The Taipei, Taiwan research Assessing Nurses' Understanding of Chemotherapy examined 203 nurses. The research yielded 60.9% correct responses.[63] According to another Malaysian cross-sectional study, respondents' average knowledge test score improved from 45.510.52 to 73.48.88 after training. This study aimed to improve cytotoxic drug nurses' safety knowledge, attitudes, and practices[64]. Esmail et al. found in 2016 that 59.3% of nurses had fair understanding of chemotherapeutic safety management, whereas 40.7% had exceptional knowledge. Additionally, 18.52% of nurse practitioners have received cytotoxic medicine supervision training[35].

Eighty registered nurses from six Iranian university hospitals were investigated for the same objective. 52.5 percent of nurses had knowledge greater than the mean and relatively acceptable, 73.8% were prepared for cancer practice, and 43.8% received continued training based on the research[38]. Scientific investigation showed that most nurses understood chemotherapy agent safety precautions, 40% did not, and 27.8% had received in-service training. A descriptive study of 40 Punjabi nurses [65] provided this information.

Similar research at the Tanta oncology treatment center and the cancer division of Menoufia teaching hospital found that group study II respondents had 61.1% poor general knowledge, whereas 77.8% had fair.[41] Most participants had never received chemoradiotherapy safety instruction. This result matches research in Erbil City, Iraq (81.43%) and South Egypt (82.8%).[34, 35]. In an Iranian cross-sectional research on oncology nurses' knowledge, attitude, and performance with antineoplastic medications, nurses scored 9.431.5 out of 12, with 12 being the highest score.[57] A research of 35 nurses in south Egypt examined the influence of developed nursing protocols on nurses' knowledge and clinical practice and found that 85.7% had insufficient knowledge[36]. In a similar country, occupational health and safety programs improved knowledge and practice among chemotherapy-exposed nurses, and the knowledge score was 4.0, indicating that CDs handling courses were not satisfactory[53].

In 2021, Asefa et al. examined oncology nurses in Addis Ababa's tertiary teaching hospitals' cytotoxic medication safety knowledge and practices [45]. A hospital-based cross-sectional research included 77 nurses. The responders were chosen deliberately. Interviews were self-administered to complete predefined questions. Their main findings showed that nurses' knowledge and practice averaged 7.82 out of 15 and 22.1 out of 40. None of the nurses who answered to the poll utilized all of their PPE, and approximately 69% reported no CD handling training at

their workplaces. Nurses without CD experience scored 0.33 percent lower on knowledge. Higher knowledge-score nurses practiced CDs safely 0.33 points more than those with lower scores, while married nurses practiced CDs safely 0.27 points less than non-married nurses. This study found that nurses' cytotoxic drug handling skills are weak.[47]

Zayed et al. [46] examined the CD security knowledge, attitudes, and behaviors (KAP) of Tanta University Hospital cancer nursing personnel in Egypt. Tanta University Hospitals' Specialist clinic in Egypt conducted a numerous cross-sectional study from February to April 2018. Nurses' CD management expertise was assessed using a pre-designed survey. Key results showed 55 nurses actively engaged in the study. At 63.6 percent of the trial cohort, nurses' safety CD treatment KAPs were satisfactory. The results for knowledge, attitudes, and behaviors were 19.05 4.8 out of 26, 13.09 3.07 out of 16, and 8.87 1.35 out of 12. Nearly 50% of nurses have Oncology experience. PPE has been misused during CD handling. Conclusion: Oncology nurses showed inadequate safe CD handling and poor suggestion implementation, needing periodic in-service education and auditing standards to monitor and analyze their performance [46].

Sargidy, et al. [47] investigated Sudan's oncology nurses at Khartoum Oncology Hospital and their CD handling, administration, and disposal expertise. A team of professionals created an instrument to assess cancer nursing skills in handling, administration, and disposal. Sudan's Khartoum Oncology Hospital hired 78 oncology nurses for the study in March 2020. The study found that nurses scored 12.7 3.9 out of 26 on CD knowledge. Their expertise showed poor performance in safe handling (mean = 2.0 1.5 from eight knowledge questions), fantastic performance in administration (mean = 6.2 1.7 out of 10), and poor performance in sewage treatment. Simple linear regression showed that education and training predict nursing knowledge. Sudanese nurses require better CD knowledge and safety skills. Cytotoxic waste management must be regulated to reduce health concerns and medical pollution[47].

4. Literature on nurse's practice in safe handling of cytotoxic drug

According to a descriptive study in India on nurses' safety measures when handling chemotherapy drugs, 56% had poor practice in handling cytotoxic drugs and 44% had good practice [37].In yet another research of 27 nurses in Erbil City cancer departments, 63% of oncology nurses who handled antineoplastic drugs got a mean practice score of 13.414.7 out of 23, with 23 being the maximum [30].In a comparable research on cytotoxic

drug protective behaviors in the same country, the mean practice score was 21.1 with a standard deviation of 3.76. The average score of nurses' safe handling of anti-neoplastic drugs in six Iranian university hospitals was 50.3510.21 out of 60, which was regarded satisfactory[38].

Another Malaysian research on nurses found that practice test scores rose from 7.6 to 5.51 out of 20 to 15.3 to 2.55 after training[44]. In a cross-sectional research at four Urmia University hospitals in Iran, nurses' knowledge, attitude, and performance with cytotoxic anticancer medications were assessed. The typical practice score was 13.41[46]. Another research at the Menoufia University hospital and Tanta cancer treatment center found that 71.1% and 94.4% of patients had poor overall practice scores[29]. Kenyan health personnel' cytotoxic medicine safety knowledge and practices were examined in a cross-sectional research. Practice scores were 33.94% fair, 16.51% terrible, and 49.54% well[50].

In another descriptive research in Punjab, India, 32% of staff nurses used safety cabinet devices for chemotherapeutic medication safety [45]. A comparative cross-sectional study of 73 nurses at a university hospital in Edirne, Turkey, revealed that 96.9% utilized gloves while preparing and dispensing anticancer drugs. Masks were worn by 78.1%, aprons by 56.3%, and goggles by 3.1%[51]. People made antineoplastics in 46.9% of safety cabinets. Another Zagazig University hospital survey found that over 72.0% of nurses produce CDs in the treatment room[42]. A Nigerian cross-sectional survey found that 84% of participants always wear gloves while providing medicine, 55% sometimes use face masks and goggles, and 20% never do. Also, 53% donned protective aprons[36]. A study found that businesses don't usually provide chemotherapy workers with protective gear[52].

5. Factors related to nurse’s knowledge and practice on safe handling of cytotoxic drugs

In Nagpur's Saint Tukdoji Maharaj Cancer Hospital, gender, chemotherapy training, experience, and age impact nurses' practice[37]. Another Iranian cross-sectional study found a significant Spearman test link between age, years of job experience, and cancer hospital time and knowledge and practice[38]. A Kenyan study employing Fisher's exact test revealed no statistically significant relationship between demographic characteristics (age, sex, marital status, and education) and knowledge and practice[50]. Mohamed (2015) found a significant difference between nurses' knowledge ratings and years of experience, but not age or gender during practice. Another South Egyptian study revealed this.

Senior nurses learnt more than rookies, according to Zagazig University hospital studies. Study revealed no influence of socio-demographic data on knowledge and performance[42]. In another Tehran research, demographic and occupational factors did not alter nurses' knowledge [56]. Another study by Adugna, Argaw, and Berhane (2021) studied Ethiopian public hospital nurses' knowledge and factors about cytotoxic extravasation prevention and management. Primary findings revealed 34.7% of responders could prevent and cure cytotoxic extravasation. Nurses learn 6.6 times more about cytotoxic extravasation prevention and therapy. Cytotoxic extravasation prevention and therapy were unfamiliar to 65.3% of survey respondents. Cytotoxic extravasation training was insufficient in 66.9% of nurses. Educating cancer center oncology nurses about extravasation is crucial.[57]

60% of nurses from 84% mixing hazardous medicines (HDs) utilized chemotherapeutic gloves, while others used less protective gloves.[58]. Oncology nurses in outpatient and office settings utilized laboratory coats 55% of the time and respiratory protection around 6%, suggesting inadequate PPE and OSAH compliance [59]. Outpatient oncology nurses reported accidental chemotherapeutic agent exposure to skin or eyes. The analysis indicated adequate staffing and standard practice knowledge to protect nurses [60]. Another study by Ashley (2011) found that poor communication, medicine preparation, and unawareness of personal and public risk exposure may produce a hazardous workplace.[60]. Other study suggests that lack of information, a safe environment, and medicine management abilities induce increased chemotherapeutic interaction[61]. Oncology nurses made chemotherapy preparation and administration blunders due to overburden (49.7%) and staff scarcity (36.5%), according to a 2015 Turkish study. They demonstrate that chemotherapy preparation and administration are error-prone[62].

Fuller, et al. [63] revealed that most nurses were unaware of HD exposure and dangers despite NIOSH guidelines. Although HDs exposure is dangerous to nurses and their families, just 20% of healthcare professionals use double chemotherapeutic gloves, 85% wear one, and 58% [34]. Another AD safety study in Egypt reported insufficient medical monitoring, exercise, handling, and PPE usage [64]. Under half of Turkish nurses use biological safety cabinets and don't wear PPE[65, 66]. Two Iranian studies indicated that AD management seldom follows guidelines[67, 68].

6. Conceptualizing Cytotoxic Drugs in Oncology Nursing

Cytotoxic medications, sometimes known as chemotherapy, are a fundamental component of cancer treatment. When considering these medications in the field of cancer nursing, it is important to

acknowledge their complex and important function. These drugs are specifically developed to precisely target and eliminate cells that divide quickly, such as cancer cells, and hinder their capacity to multiply. Nevertheless, the therapeutic efficacy of cytotoxic medications extends beyond malignant tissues, since they may also impact normal cells, resulting in various adverse consequences.

Oncology nurses consider more than just the pharmacological aspects when conceptualizing cytotoxic medicines. It involves comprehending the intricate equilibrium between the possible advantages of destroying cancer cells and the potential damage to healthy tissues. Understanding this idea is crucial for making well-informed judgments when it comes to the safe administration of cytotoxic medications. In addition, oncology nurses must have a thorough understanding of the wider scope of cytotoxic medications within the whole process of cancer treatment. This involves identifying the many stages of cancer treatment in which these medications are used, ranging from the initial diagnosis to adjuvant therapy, palliative care, or neoadjuvant treatment to prepare patients for surgery or radiation therapy. The nurses' understanding of cytotoxic medicines includes their function in symptom control and improving patients' quality of life.

This part is based on nursing theories and ideas that focus on patient-centered care, evidence-based practice, and the nurse's role as a caretaker, advocate, and educator. These theoretical notions assist us in examining how oncology nurses in Palestine perceive cytotoxic medications, incorporate this knowledge into their everyday work, and aim to maintain a balance between the therapeutic benefits of these treatments and the safety and welfare of their patients.

i. Nursing Role in Cytotoxic Drug Management

Oncology nurses play a crucial role in assuring the safety of cancer patients by handling, preparing, and administering cytotoxic medications. Within the overarching theoretical framework of nursing practice, oncology nurses fulfill the roles of advocates, caretakers, educators, and coordinators of care for persons receiving cancer treatment. The crucial aspect of their duty is to provide patient education and assistance. Oncology nurses have the responsibility of providing patients with crucial information, such as the specifics of their treatment regimens, possible adverse effects, and techniques for self-care. Nurses fit with theoretical models such as the Teaching-Learning Theory and the Health Promotion Model by equipping patients with the necessary knowledge and skills to actively participate in their treatment.

These models highlight the need of patient education and involvement in self-care.

In addition, oncology nurses are responsible for strictly following stringent safety standards and rules while administering cytotoxic medications. Prioritizing patient safety is of utmost importance, and their dedication to this element of their job is consistent with theoretical frameworks such as the Health Belief Model. This model aids in comprehending how nurses' beliefs of the risks and benefits connected with cytotoxic medications impact their compliance with safety protocols. Interdisciplinary teamwork is an essential aspect of the nursing role in managing cytotoxic drugs. Efficient communication and coordination with doctors, pharmacists, and other healthcare professionals are essential for planning treatment regimens, evaluating patient reactions, and managing any side effects. This collaborative approach aligns with nursing ideas that highlight the significance of cooperation and multidisciplinary care.

Patient advocacy is an essential aspect of nursing practice, and this is especially relevant when it comes to managing cytotoxic drugs. Oncology nurses champion the best interests of their patients, guaranteeing that treatment programs are in accordance with patients' choices and values. Nurses use ethical frameworks, such as the Ethical Decision-Making Framework, to assist them in addressing intricate ethical difficulties that may occur when administering cytotoxic medications.

Finally, the nursing position is upon providing excellent care and enforcing safety protocols. Nursing approaches, such as the Quality and Safety Education for Nurses (QSEN) framework, that stress patient-centered care and safety, guide nurses in efficiently and safely handling cytotoxic medications.

b. Conclusion

Nurses have little understanding and inadequate implementation of cytotoxic medication safety protocols. Over 50% of the nurses received training in chemotherapy administration. The nurses clearly shown a deficiency in the required training. Significant variations in the average knowledge score about cytotoxic drugs were observed among oncology nurses, which were influenced by age and years of experience. Furthermore, a statistical association was seen between the average knowledge and practice scores of oncology nurses and their age and educational level. Additionally, a correlation was found between the practice of receiving and storing cytotoxic medicine. The research revealed that nurses used gloves and masks more often as personal protective equipment while dealing with cytotoxic medications. However, individuals did not use all the necessary protective equipment when dealing with

cytotoxic medications throughout their production, transportation, and disposal. The prevailing inference indicates a decrease in the number of individuals who use gloves during food preparation. Therefore, it is essential to provide oncology nurses employed in cancer centers with instruction, safety monitoring systems, personal protective equipment, and established protocols.

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